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## Achenial hairs of *Compositæ*.

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WITH PLATE XXXV.

In the older systems of classification little attention was given to the anatomical structure of plants. It was sufficient to consider only morphological characters. There is, however, a growing tendency to study the minute anatomy and bring it into requisition, as Engler and Prantl have done in many cases in their admirable work "Die natürlichen Pflanzenfamilien."

Many botanists have made comparative studies of different orders, as Leonhard<sup>1</sup> has done for the *Apocynaceæ*, Kuntze<sup>2</sup> on comparative anatomy of *Malvaceæ* and Schumann<sup>3</sup> on the limits of anatomical variation in the same species. American botanists have not been slow to make use of anatomical characters when they could do so. Thus Engelmann<sup>4</sup> long ago called attention to the valuable characters found in the anatomy of the pine leaf. Later Coulter and Rose<sup>5</sup> made a comparative study of our North American pines. They also studied the fruits of *Umbelliferæ*.<sup>6</sup>

In the difficult task of classifying the order *Compositæ* the most minute details of structure are brought into requisition for the determination of species.

In a paper recently prepared on the style-characters of the *Compositæ*, Chamberlain<sup>7</sup> calls attention to the revisions made in the order since the elaboration of the same by Linnaeus who divided it into four groups. He notes the fact that Henri Cassini, Lessing, De Candolle, Bentham, and Gray have made use of the style characters in the arrangement of

<sup>1</sup>LEONHARD, MICHAEL: Beiträge zur Apocynaceen, Bot. Centralblatt. XLV. I, 33, 65, 97, and 129.

<sup>2</sup>KUNTZE, GEORGE: Beiträge zur vergleichenden Anatomie der Malvaceen, Bot. Centralblatt. XLV. 161, 197, 229.

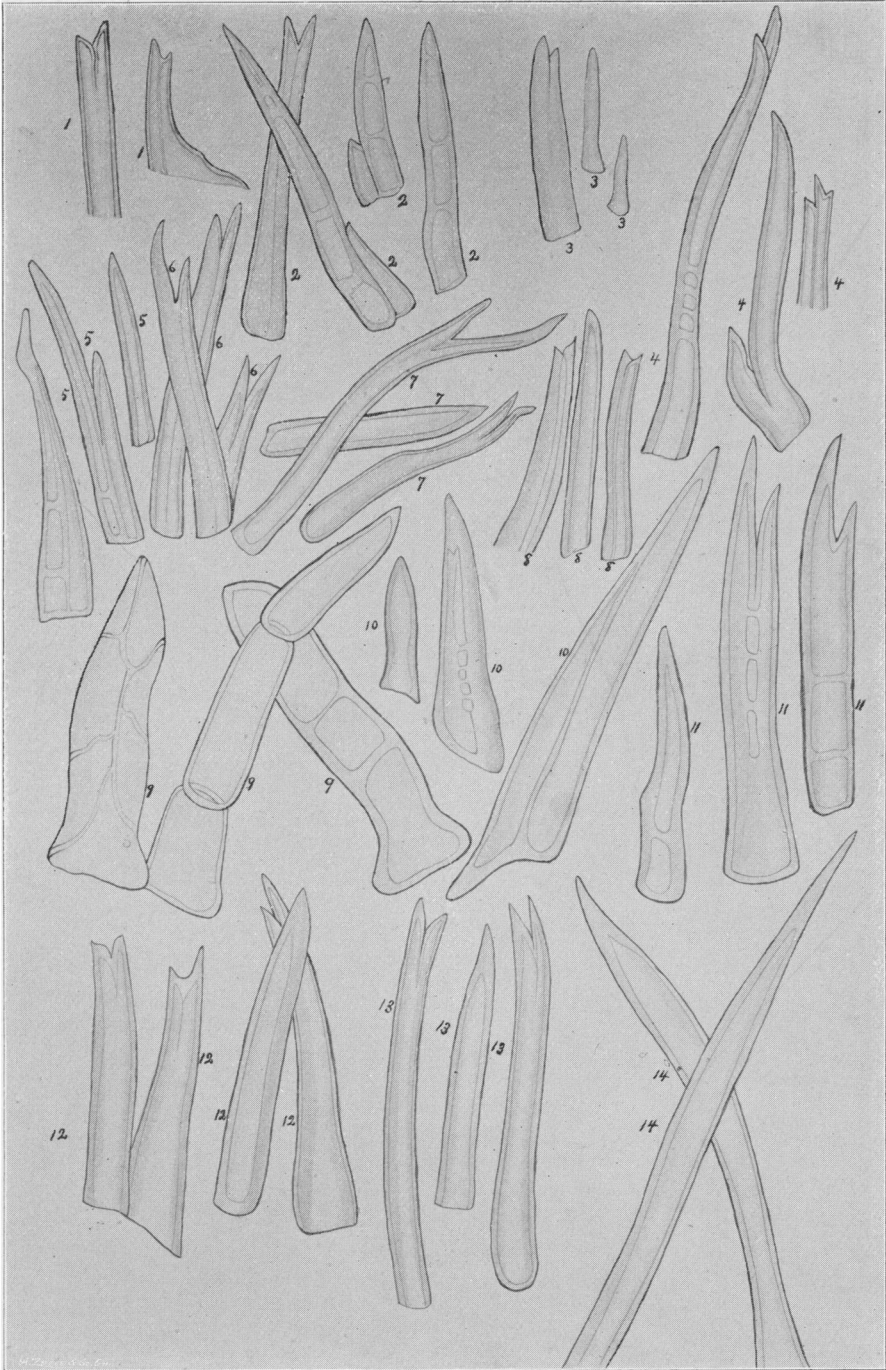
<sup>3</sup>SCHUMANN, PAUL: Beiträge zur Kenntniss der Grenzen der Variation im anatomischen Bau derselben Pflanzenart, Bot. Centralblatt. XLV. 356, 389, and XLVI. I.

<sup>4</sup>ENGELMANN, GEORGE: Trans. St. Louis Academy of Sciences. III. 595, 602.

<sup>5</sup>COULTER, J. M. and ROSE, J. N.: Synopsis of North American Pines, based upon leaf anatomy, Bot. Gazette. XI. 256, 302.

<sup>6</sup>Notes on Umbelliferæ of East U. S. Bot. Gazette. XII. 12, 60, 73, 102, 134, 157, 261, 291.

<sup>7</sup>CHAMBERLAIN, J. S.: Comparative study of the styles of *Compositæ*, Bull. Torr. Bot. Club, XVIII. 175.



NICHOLS on ACHENIAL HAIRS.

the order, and further states that the pappus is of greater diagnostic value than the achenium. Whether or not the statement with reference to the achenia will stand, remains to be shown. Little attention has been given to a microscopic study of achenia but Macloskie<sup>8</sup> and Loose<sup>9</sup> have both studied the minute structure of the achenia of *Compositæ*.

Gray, in his manual, frequently notes the presence of achenial hairs, but comparatively little microscopic work has been done on the anatomy and physiology of these organs. Hence their value as specific characters remains to be determined.

The hairs on the *Compositæ*, especially those of *Senecionidæ*, are of peculiar interest.

The subject has been discussed by Pammel<sup>10</sup> and references given.

Harz<sup>11</sup> figures achenial hairs on *Taraxacum* and the more or less papillose cells of *Scorzonera*. Loose makes the statement that the anatomical characters of the fruit in a genus are usually alike although exceptions are found in *Anthemis*, *Pyrethrum*, and *Chrysanthemum*. He figures the hairs on *Callistephus Chinensis* and *Zinnia verticillata* in his *Fruchtschale der Compositen*.

Heineck<sup>12</sup> incidentally refers to the anatomical structure of the hairs on the fruits of *Compositæ*, but he was chiefly interested with reference to their mechanical function.

Macloskie<sup>8</sup> points out similarities of achenial-hair structure in the more closely allied groups and also notes a discrepancy in the group *Cynaroideæ*, which, if this be made a basis of classification, would lead to the division of the group, placing *Carlina* and *Xeranthemum* nearer the *Asteroideæ* while the true thistles, in the absence of hairs, resemble the members of the group *Cichorieæ*. Macloskie has further described and figured the hairs on different genera of other tribes of this order.

<sup>8</sup>MACLOSIE, GEO.: Amer. Naturalist, Jan. 1883.

<sup>9</sup>LOOSE, RICHARD: Die Bedeutung der Frucht und Samenschale der Compositen für den ruhenden und keimenden Samen, Inaugural Dissertation, Berlin, 1891.

<sup>10</sup>PAMMEL, L. H.: On the seed-coats of the genus Euphorbia, Trans. St. Louis Acad. of Sciences, v, no. 3. He gives a list of papers bearing on the subject of mucilaginous cell-walls in this paper.

<sup>11</sup>HARZ: Landwirtschaftliche Samen Kunde, II. 843-866. Paul Parey, Berlin, 1885.

<sup>12</sup>HEINECK: Beitrag zur Kenntniss des feineren Baues der Fruchtschale der Compositen. Inaugural Diss. 1890.

In the preparation of this paper, two types of achenial hairs have been observed: 1. a simple, pointed hair having, apparently, no median line or division wall; 2. a compound or double hair, branching so as to form a double-pointed apex. The former will be designated as "simple" and the latter, with all modifications, will be included under "duplex hairs," a term used by Macloskie.

Of the entire list studied, the only simple hairs found were in *Rudbeckia* and *Centaurea*.

Those found to bear duplex hairs are *Eupatorium*, *Aster*, *Coreopsis*, *Dysodia*, *Bigelovia*, *Bidens*, *Kuhnia*, and *Liatris*.

As may be seen, this division does not follow closely the established lines of group division. Aside from the digression already noted by Macloskie in the group *Cynaroideæ* may be mentioned the fact that *Centaurea*, of this same group, has long simple hairs. This puts into one group the three possible divisions which may be made with reference to achenial hairs. In the *Helianthoideæ* also several genera, as *Helianthus*, *Coreopsis*, and *Bidens*, present distinct duplex hairs; on *Lepachys* they are of the simple kind and on *Xanthium* and *Silphium* no hairs are found. Among the *Aster-oideæ*, the genera *Aster* and *Bigelovia* have conspicuous duplex hairs while on others, as *Grindelia* and *Erigeron*, no hairs are found.

In other groups similar differences occur which would seem to preclude the possibility, or at least the advisability, of accepting these as tribal characters. Within the genus however, the character seems to be more constant and might, perhaps, be made of value in the determination of species.

In *Eupatorium villosum* Swartz the hairs are comparatively short and have lateral canals which appear also to form or to follow the division wall in those duplex hairs in which this wall is visible. Whether the non-appearance of this wall in some duplex hairs was due to the accidental placing of the hair upon the slide or to the fact that this is an inconstant structural character, the writer was unable to determine.

In *Liatris gracilis* Pursh a number of the hairs when first examined appeared simple, but closer investigation revealed, in nearly every case, a rudimentary growth at the base, establishing the duplex character of the hair. In these hairs cross canals were plainly noticeable, especially after the application of glycerine.

The hairs of *Kuhnia eupatorioides* L. present few structural characters and on the whole, seem imperfect. No canals or division walls appear. Many of the hairs are small and show neither the double tip nor the basal rudiment. If these specimens should prove perfect and this irregularity a fixed character it might materially alter conclusions, but it is probable that further examination will prove the hairs of *Kuhnia* to be duplex and these specimens imperfect.

The asters all have long, distinct, duplex hairs. *Aster macrophyllus* L. has some duplex only at the base and in another case three tips were distinguished. The lateral canals are distinct, but their walls are sometimes broken, affording transverse communications. In *Aster laevis* L. are found the same characters. Although in two thirds of the specimens only one tip is visible, yet the hairs have every other appearance of being duplex. The hairs from *Aster oblongifolius* Nutt. are somewhat thicker and have sharply pointed tips. The tip form, however, varies too much within the species to give it any specific value. In many cases in *Aster Novæ-Angliæ* L. the tips are deeply cleft and of unequal length, but here too the variations are so great as not to offer any specific characters.

*Bigelovia nudata* DC. presents a slight irregularity of appearance. The canals seem to extend through the center of the hair. This may, however, be due to the position and transparency of the hair, which, combined, give to the division wall the appearance of a canal. This supposition seems more probable since in the cases where only one half of the hair is developed, the canals are in the usual lateral position.

*Rudbeckia pinnata* Vent. introduces us to the group *Helianthoideæ* and presents a marked contrast to any of the preceding. The hairs are much thicker and less acutely pointed. In one case the canals seem to ramify irregularly. In another case the hair appears to be distinctly jointed, while a third form has the usual structure, lateral canals and transverse connections.

In *Bidens frondosa* L., also of the group *Helianthoideæ*, the hairs seem at first to be simple but close study shows irregularities of structure which would make them of the duplex type, at least in the more mature stages. The fact that some of the younger growths are so distinctly simple might indicate that the two parts do not always develop

simultaneously. These hairs also show unusual differences of length.

*Coreopsis aristosa* Michx. is very similar to the preceding. The hairs are of various lengths and diameters, have lateral canals, and are probably all duplex when perfectly developed.

*Helianthus occidentalis* Riddell of the same group, is also very similar, except that the tip is perhaps less deeply cleft. Occasional specimens seem simple except for a line through the center, answering to the median wall.

In *Dysodia papposa* (Vent.) Hitchcock, the hairs are rather more slender, double tipped, but show no division wall.

In *Centaurea Cyanus* L. they are very long, slender, and indistinct. No transverse canals are found, and the apex is sharply pointed.

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EXPLANATION OF PLATE XXXV.—1. *Eupatorium villosus* Swartz.—2. *Liatris gracilis* Pursh.—3. *Kuhnia eupatorioides* L.—4. *Aster macrophyllus* L.—5. *Aster laevis* L.—6. *Aster oblongifolius* Nutt.—7. *Aster Novæ Angliæ* L.—8. *Bigelovia nudata* DC.—9. *Rudbeckia pinnata* Vent.—10. *Bidens frondosa* L.—11. *Coreopsis aristosa* Michx.—12. *Helianthus occidentalis* Riddell.—13. *Dysodia papposa* (Vent.) Hitchcock.—14. *Centaurea Cyanus* L.